per pound for Thompson's Seedless, 6½ cents per pound for Sultanas and an estimated price of 4½ cents per pound for sundry raisins netted the growers an aggregate sum of $19,743,750.

To arrive at the net profit of the growers of raisins there should be deducted from this aggregate figure the harvesting expense, the cost of drying and the care and cultivation of the vineyards. If untimely rains had not interfered with the raisin production and damaged a large quantity of the product the yield of raisins in California would probably have exceeded 180,000 tons.

The product was sold to good advantage and there was practically no competition from imports of raisins or currants.

TABLE GRAPE PRODUCTION.

Absolutely accurate figures as to the number of carloads of table grapes produced in California and sold as such are not obtainable. A systematic investigation at many shipping points and a thorough checking of carload shipments in the general offices of the Southern Pacific, Santa Fe and Western Pacific railroads discloses the fact that a total of 18,189 cars of grapes were loaded in refrigerator service for transportation out of the state. Of this total number it is estimated that 6,000 cars were wine grapes shipped and sold as such, leaving 12,189 carloads of table grapes sent out of the state. It is generally estimated that 1,000 cars of table grapes are consumed in California or sent out of the state in small express shipments; so, therefore, the most intelligent estimate we can make of the number of cars of table grapes produced in the state is 13,189 cars.

The estimated average price received by the grower for a carload of grapes packed and loaded at the shipping point is $1,250. On this basis table grape growers received for their table grapes $16,487,250.

From this total received for table grapes must be deducted the cost of harvesting the crop, the cost of the crates and the packing charges and the attendant expense in connection with the care of the vineyard.

The viticultural industry in the state in all three branches has, therefore, brought to the producers of the grapes the annual income of $46,220,250 for the year 1918.

Respectfully submitted.

STATE BOARD OF VITICULTURAL COMMISSIONERS,
C. J. WETMORE, President.
E. M. SHEEHAN, Secretary.

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Possible Uses for Wine Grape Vineyards

BULLETIN No. 14

ISSUED MAY 20, 1919, BY THE
State Board of Viticultural Commissioners
IN CONNECTION WITH THE
Division of Viticulture, University of California

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ISSUED BY THE

STATE BOARD OF VITICULTURAL COMMISSIONERS

SACRAMENTO, CALIFORNIA, MAY 20, 1919

POSSIBLE USES FOR WINE-GRAPE VINEYARDS

By Frederic T. Bioletti and W. V. Cruess.

There are about 170,000 acres of wine-grape vineyards in California. The cost of establishing these vineyards, exclusive of the land, has been over $25,000,000. The product for 1918 returned to the growers over $10,000,000.

The prohibition of the use of grapes for wine-making threatens the total loss of all this value. To this loss must be added the cost of the removal of the vines before the land can be used for other crops. This alone will amount to about $2,000,000. All methods which offer any hope of preventing even a portion of this loss are worth considering. In a few cases the salvage may be considerable; in others, all that can be done is to avoid increasing the loss by unwise or unskillful attempts to utilize the crop or to change it.

The methods proposed and listed here are of four types: (*a*) Shipping the fresh grapes to countries which do not prohibit wine-making; (*b*) utilization of the grapes for other purposes than wine-making; (*c*) grafting the vines with raisin and table varieties; (*d*) replacing the vines with other crops.

A. SHIPPING THE FRESH GRAPES.

In 1918 six thousand cars of wine grapes were shipped out of the state and brought to the growers about $2,700,000. These grapes were shipped to eastern parts of the United States, where they brought good prices. These shipments might be continued and even increased if individuals were permitted to make wine for their own use as with cider in Maine. This possibility, however, is doubtful. A small amount might be disposed of in a similar way in Mexico. Shipment of wine grapes to greater distances is impracticable with our present methods,

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so that there is little hope of utilizing any considerable portion of the crop in this way.

B. USE OF THE GRAPES FOR OTHER PURPOSES.

1. *Drying and Evaporation*: In the raisin districts (the interior), the wine grapes can be sun-dried by the methods in use for Muscat and Sultanina. In the dry-wine districts (the coast counties), they can be dried in evaporators.

In 1918, about 4,000 tons of sun-dried wine grapes were produced in California and sold for an average price of over 4½ cents, in some cases bringing higher prices than raisin grapes. Experiments by the College of Agriculture with eleven varieties of wine grapes indicate a slightly better drying ratio for wine grapes than for Muscats. In 1916, with an average sugar content of 25.2° Balling, 3.13 pounds of fresh grapes yielded one pound of dried; in 1917, with 22.21° Balling, the same varieties yielded at the rate of 3.68 pounds of fresh to one of dry. At 4½ cents per pound for the dried grapes, and allowing $15 per ton for harvesting and drying, this represents a price of $14.45 per ton on the vines for fresh grapes at 23° Balling.

Wine grapes of some varieties, especially the white, such as Palomino and Feher Szagos, yield a dried product that is of fair to good quality for use in cooking. Most varieties are of poor quality for this purpose. It is probable that most of them are used in wine-making. Sweet wines of good quality can be made from them. For dry wines, they are less suitable, as the red color is destroyed and the wine has a "rancio" or "sherry" taste.

Sun-drying is impossible in the dry wine districts because the grapes ripen too late and the air is not sufficiently hot nor dry. Drying in evaporators, however, is possible by the methods used in the Sacramento Valley in the production of Sultana raisins. These methods consist of dipping the grapes in a hot solution, to check the skins, and then drying in a tunnel or other form of evaporator. Directly after dipping the grapes are often sulfured. Moderate sulfuring would probably be advisable with wine grapes.

Grapes have been dried in this way for $15 to $20 per ton of dried product, reckoning neither harvesting nor hauling. The cost is somewhat higher than that of sun-drying. The quality, however, for most of the purposes for which dried wine grapes would be used would be higher. When properly dried in an evaporator the red color is retained to a great extent and grapes raised in the coast counties and dried in this way would be much superior to sun-dried grapes for making dry wine.

As a gallon of wine could be made from about four pounds of dried grapes, they would have to be sold to the wine-maker for 6 cents or 7 cents per pound to compete with fresh grapes in wine-making regions

under ordinary conditions. In regions where wine grapes are not raised, as in most parts of the United States, they might bring nearly twice this price.

Experiments by the College of Agriculture indicate that dried grapes form an excellent food for hogs, if used in moderation. For this purpose they have about the same value as rolled barley. This represents a price, however, which would not pay the cost of production. If we allow a minimum cost of drying of $15 and a maximum yield of 3⅓ pounds of fresh grapes to one of dry, a price of $40 per ton to compete with rolled barley would yield the grower only $7.50 per ton for fresh grapes delivered at the dryer.

2. *Grape Syrup*: The possibility of the manufacture of grape syrups of several kinds and of excellent quality has been abundantly demonstrated. The only doubt at present is whether a market can be developed for these syrups in time to save the vineyards and whether the consumer will pay a sufficient price to yield a profit on the growing of the grapes and the manufacture of the syrup. If the syrups have to compete on the score of price with syrups made from cane, beets, or sorghum, this is extremely doubtful. As some of the grape syrups, however, have valuable qualities not possessed by others, it may be possible to obtain a remunerative price on the score of quality.

Two general types of syrups have been made: (*a*) Those in which little of the grape flavor is left. These are called neutral-flavored syrups. (*b*) Those which retain as much as possible of the special flavors of the grapes. In each of these general types we have subtypes according to whether the color is white, red, or various shades of brown or yellow. These variations of color depend on the method of manufacture and the kind of grape. Other variations are introduced by the more or less complete neutralization of the natural acidity of the grapes.

The uses of these syrups will vary with their character. The neutral syrups will be used for the same purposes as the ordinary syrups with which they will come in direct competition. Only when the prices of these syrups are abnormally high is there any possibility of marketing neutral grape syrups at a paying price.

The syrups which retain more of the characteristics of the grapes, however, may find a special outlet of their own at higher prices.

Many consumers prefer the syrups with a full grape flavor, while the acidity and red color are attractive to others. The acid and red grape syrups are especially promising for use in making summer drinks, candies, ice cream flavoring, and various confections.

The processes of manufacture are as various as the kinds of syrup.

Sorghum Pans: The simplest method of making grape syrup is by means of shallow open pans heated by direct fire or steam coils, such as are used for sorghum, cane, and maple syrup. This method has been used successfully and profitably on a small scale in California. A con-

venient outfit is described in Circular 198 of the College of Agriculture, Berkeley, Cal. The pan must be lined with tin to resist the action of the acid of the grape juice. This is probably the best method for the small producer.

Sun Evaporation: A method of concentrating grape juice by the direct action of the sun and dry air was invented by Addison G. Waterhouse. It consists in causing the juice to run on sheets of cheesecloth well exposed to the wind and sun. The method is rapid, is easily applied to small quantities for home use, and could be adapted to large scale operations. Syrups made at the college on a small scale by this process had a raisin flavor but were very palatable.

Both of these methods result in a large exposure of the syrup to the air which modifies its color and flavor.

Vacuum Pans: Most commercial syrups are concentrated in vacuum pans. By this means the process is hastened, lower temperatures can be used, and the action of the air is diminished. Adaptations of this method suited to grape juice are described in Bulletin 303 of the College of Agriculture, Berkeley, Cal. Various types of syrup can be made by this means, depending for their character, principally, on the treatment of the grape juice before evaporation.

A light colored syrup with very little acidity can be made by neutralizing most of the acid and decolorizing by filtration through bone black. Such a syrup is suitable for use in canning, but could not compete with ordinary sugar for this purpose at ordinary times. By omitting or diminishing the decolorizing, a golden or darker syrup suitable for table use can be made which is preferred by many to cane syrup.

By using red grapes and extracting their color by heating the crushed grapes for about eight hours to 120° F., a red juice is obtained. This juice is then cleared by heating to 160° to 170° F. to coagulate the proteins and gums, settling for 24 hours, and filtration in a filter-press through "Filter-Cel." The clear red juice is then concentrated rapidly at a vacuum of 24 inches or more to 65° Balling.

After settling for about two weeks to allow of the separation of the cream of tartar, it is drawn off, bottled, or placed in enamel-lined fruit cans and pasteurized at 160° F. for one hour.

The flavor and color of syrup made in this way are very attractive. A Muscat flavor can be obtained by using equal quantities of ripe Muscat grapes with the red wine grapes. This syrup is well adapted for table use and would be useful in the preparation of ice cream soda and other cooling drinks.

The cream of tartar recovered would be a valuable by-product. Experiments indicate a probable yield of about five pounds from one ton of grapes.

Serailian Process: Concentration in the ordinary vacuum pans destroys much of the flavor of the grape which passes off as volatile

aromas with the water. A machine has been devised by M. K. Serailian of San Francisco which condenses these aromatic matters and returns them to the syrup. Syrups made in this way retain more of the special flavors of the grapes. It can be applied to red, white, or deacidified juices. These syrups would be peculiarly fitted for cases where a highly flavored syrup is desired.

Monti Process: In all the foregoing methods concentration is accomplished by driving off the water by heat. In the Monti process and related methods the concentration is accomplished by freezing. By subjecting grape juice to a sufficiently low temperature, ice is formed. If this ice or frozen water is removed, the liquid remaining is concentrated.

There are various ways of applying the Monti process but they all depend on cooling the grape juice until fine crystals of ice are formed and then separating the solid crystals from the liquid syrup. In the Monti apparatus the process is continuous, the entering juice being separated into water and syrup which flow out. This process is covered by United States Patent No. 955,659, a copy of which can be obtained for 5 cents from the United States Patent Office, Washington, D. C. French patents (324,474, 357,770, 390,085, 447,379, 459,141) all bear on this method.

Gore Process: A process based on the same principle has been devised by A. C. Gore of the United States Department of Agriculture. The juice is first frozen into solid blocks in an ordinary ice-making machine. These blocks are then coarsely ground and placed in a centrifuge where the solid ice and the liquid syrup are separated. This process can be used by anyone without royalty.

By these freezing processes, a syrup can be concentrated only to about 60° Balling, which is rather thin. Its thickness can be increased by concentrating half of it in a vacuum pan to 70° Balling and blending with the other half. The blend of 65° Balling can then be sterilized in bottles or other containers.

Syrups are said to be made in Italy and Greece on a large scale by the freezing process. The absence of exposure to heat results in conserving the natural flavors of the grape and avoiding the flavors due to cooking and oxidation.

Spray Process: Through the co-operation of Mr. C. E. Gray of the California Central Creameries, several experiments were made with a machine used for producing milk powder. The milk is sprayed or "atomized" into a large chamber through which a large volume of hot air is blown. The small droplets of milk are dried almost instantaneously, forming a powder which is recovered by settling or other means.

Attempts to dry grape juice were made with this machine, using temperatures ranging from 125° F. to 220° F. At all these temperatures, it was possible to dehydrate the juice completely, but even at the

lowest temperature used the dried product was melted, forming a syrup. On cooling to room temperature, this syrup solidified to a glassy mass. This solid mass quickly absorbed moisture from the air and became a syrup. If sealed in air-tight containers while still dry and solid, it would undoubtedly keep perfectly. It occupies a very small volume, is readily soluble in water, and forms a syrup of better flavor than that produced by the ordinary vacuum pan. It is without a scorched taste and the color is retained.

A large milk evaporator would handle about 6,000 gallons of juice a day. The evaporating chamber would have to be lined with tin because the acids of the juice would rapidly attack the usual zinc lining. It would also probably be necessary to surround the evaporating chamber with a low-pressure steam jacket to melt any dried juice which might adhere to the walls.

The process could be modified to produce a syrup directly or the dried product could be packed and made into a syrup as required. The syrups are of excellent quality and flavor and may be red or white, according to the juice used.

Other Processes: Other processes are in use for the evaporation of solutions by means of a current of air. In some cases, the air is heated. In others, the liquid is heated on a revolving drum exposed to a current of air. In others, the liquid is sprayed through a revolving atomizer against the inner walls of a cylindrical chamber heated by a steam jacket. The last method is said to have been used successfully in France in the production of grape syrup.

Mr. Forsyth of Gilroy states that he has made sorghum syrup of good quality by allowing the juice to flow over wooden baffles against a blast of heated air. The baffles are placed one above another in an enclosed tower. This method could probably be used with grape juice.

Cost and Returns: No accurate calculations can be made of the cost of manufacture on the basis of the small tests made. An estimate of the probable cost, however, can be made from the published costs of the manufacture of cane and sorghum syrup and from what is known of the cost of crushing and pressing grapes.

Cost Per Gallon of Grape Syrup.

Crushing, pressing, filtering	$0 03
Evaporation, storage, canning	12
Cans, labels, boxes	25
Grapes, at $17.50 per ton	32
Total	0 72

This represents the cost of the syrup in cans and boxed for shipment at the factory. To this must be added transportation, commission and profits of wholesaler and retailer. With these added, the price to the consumer would undoubtedly be higher than for common syrups, but not high for syrups of the *special* qualities and adaptation to the many

special uses that characterize grape syrups. The *special* syrups containing the color, flavor, and acidity of the grape would be most easily and cheaply prepared and would be most likely to attract *special* consumers and to command higher prices.

In the production of some of the types of syrup described, the cream of tartar would be recovered as a by-product and would decrease the net cost.

3. *Grape Juice*: There have been numerous attempts to manufacture and market grape juice from California grapes during the last twenty years or more. Most of these have failed entirely. A few have had a moderate and momentary success. Before making new attempts, the causes of previous failures should be studied.

Some of the failures were due to neglect of the first principles of food preservation. When the details of an industrial process have been well worked out, the "rule-of-thumb" man may be successful. In establishing a new industry, the theoretical bases of the processes must be understood if a correct practice is to be devised quickly. While the scientific facts on which the manufacture of grape juice in the Eastern states is based are the same as those which must govern its manufacture in California, the details of practice may be different.

Other failures were due to the use of inferior raw material. Only good grapes will make good grape juice. Grapes without flavor will make an insipid juice; moldy grapes will communicate their unpleasant flavors. Good grape juice can not be made from the culls of wine, table, or raisin grapes.

Other failures were due to the attempt to make the juice too cheaply with a consequent sacrifice of quality.

That grape juice of the highest quality can be made from suitable California grapes by appropriate methods is proved by the grape juices exhibited at the Panama-Pacific International Exposition. Those which won the chief awards were better than anything of the kind that can now be found on the market whether made from California or Eastern grapes. To establish a market for such juices is a problem similar to that of establishing a market for fine wines. To be produced profitably, they must bring a higher price than common juices, owing to the scarcity and higher cost of the fine varieties of grapes needed and to the extra expense of the careful and skillful manipulation necessary in their manufacture. A market could be established only slowly and by constant emphasis on quality rather than cheapness. They must attract the connoisseurs who determine the purchases of the consumers of luxuries.

A grape juice, to please the consumer, must have certain qualities of flavor, acidity, and color. The Eastern grape juices most commonly found on the market depend for their popularity on their strong "Labrusca" or "Concord" flavor. This flavor is so strong that it

covers up many defects of flavor such as those due to overheating, oxidation, or imperfect condition of the grapes.

None of our California grapes, with the possible exception of the Muscat, have so pronounced a flavor as the Concord. Their flavors, however, in many cases, are varied, delicate, and delicious to the discriminating palate. Very few would prefer the Concord juice to that of the Semillon, the Colombar, the Riesling, and of many others as they come fresh from the press. The problem is to present the juice to the consumer with these flavors as little changed as possible. That the Concord flavor is not of itself more pleasing to most people than that of the best California varieties is easily proved by tasting the juices of each before they have been changed by unskillful manipulation. The great majority of tasters under these conditions prefer the flavor of the California grapes and of their juices.

The high acidity of Concord juice is one of its valuable qualities. Many consumers, however, prefer the lower acidity of the California grape juice, especially when, by skillful preparation, the fresh flavors of the grapes have been preserved. Moreover, by a judicious choice of varieties and degrees of ripeness California grape juices can be produced with high acidity.

Preference of color is a matter more of habit than of taste, and any desired color can be obtained from our grapes.

If the manufacture of grape juice in California is to be a commercial success it must be based on the intrinsic qualities of the grapes and not on an attempt to compete with Eastern grape juice which appeals to a different taste.

It would probably be necessary to produce several types of juice to satisfy different tastes and to utilize our available grapes.

Muscat juices, characterized by the marked Muscat aroma, would appeal to those who prefer strong flavors. They can be made red or white and with varying degrees of acidity by blending with acid and red wine grapes. This type would require the least care and skill to produce and could therefore be made more cheaply. It has been found possible at the station to preserve white Muscat juice in cans. It is the only kind of juice made which would be likely to succeed in pleasing the consumers of Concord juice. It probably would not be relished by those who could appreciate the finer flavors of our best wine grapes. It would be particularly suited to use in cooking and preserving and could be sold at a relatively low price. Red juice loses its color in tin cans.

It is probably hopeless to attempt to market a juice made from our common varieties of wine or table grapes. These are better suited for drying or for syrup. From our fine varieties of wine grapes, however, juices of the highest quality can be made. But to make them requires both skill and judgment. Methods which may be adequate for Concord or Muscat would fail with Semillon or Riesling. We must make our

fine grape juices with the same ideals which controlled the manufacture of our fine wines. They require the same careful choice of varieties and localities and the same degree of careful manipulation. They will attract the same class of discriminating consumers and will necessarily require higher prices. Grapes grown in the dry-wine districts will give the best results. The varieties most suited for this type of juice are in the main those which centuries of experience have shown to be most suited to the production of fine wines, especially those of an aromatic nature.

Of the varieties grown in California, the most suitable probably are Semillon, Colombar, Riesling, Traminer, Palomino, and Cabernet. Varieties high in color and acidity, such as West's White Prolific, Barbera, Rofosco, Crabbe's Black Burgundy, and St. Macaire, might be useful as blends to give variety. Whether fine wine grapes of neutral flavor, such as Pinot and Petite Sirah, would be suitable is doubtful. The commoner wine grapes, such as Zinfandel, Carignane, Mataro Bouschet and Burger, are undoubtedly unsuitable.

By carbonating the finer grape juices they could be improved for most tastes. The carbonic acid not only increases the freshness of the juice but brings out the special flavors. It makes it possible to prepare the juice at lower temperatures which also tends to conserve the more delicate flavors.

Cost and Returns: Estimates of cost will vary according to the kind of juice which is contemplated. Based on small-scale tests at Davis, the cost of canned Muscat juice would be about as follows:

	Cost Per Quart Can.
1. Grapes at $20 per ton	3.1 cents
2. Crushing, pressing, filtering, canning, and pasteurizing	2.0 cents
3. Cans and labels	4.0 cents
4. Packing	2.0 cents
Total cost, f. o. b. factory	11.1 cents

It should be possible to sell this juice to the consumer for a price of 20 cents to 25 cents per quart can.

The cost of the juices of finer quality would be higher on account of the higher cost of the grapes, the more skill and labor necessary in manufacture, and the necessity of using bottles. The grapes can not be grown profitably at less than about $30 per ton and it would probably be necessary to obtain from the consumer a price at least 50 per cent higher than that estimated for Canned Muscat Juice.

4. *Vinegar*: Wine or grape vinegar is the standard in grape-growing countries and is considered the best and commands the highest price in most others. Its only serious competitor on the score of quality is cider or apple vinegar. It differs from the latter in higher flavor and greater strength. Its reputation is not high in California, owing to the fact that it has usually been made from spoiled wine by unskillful methods.

When made from good material by proper methods, it is as good here as in France. It should be clear and of clean taste. A good grape vinegar should contain about 8 per cent of acetic acid, which is twice the legal standard. It therefore can be used as economically as ordinary vinegar, even though bought for double the price and its high quality is a net gain.

To make good vinegar, sound, ripe grapes must be used. Any of our wine grapes are suitable. These grapes must be handled and fermented as carefully as in making good wine. In fact, the first step in the making of good vinegar is to make good wine. This wine is then changed to vinegar by another and different fermentation.

There are several processes used, varying in the kind of installation needed, the time of operation, and the quality of the product.

Slow Process: After the wine has been made by the usual processes of wine-making, it is drawn off the yeast and gross lees and placed in partially filled casks or small closed vats. These containers should have holes at the top of sufficient size and number to supply abundant air and be protected with netting to exclude flies. An addition of 10 per cent of strong vinegar facilitates the process and prevents unfavorable fermentations.

The process requires from 6 to 10 months, according to the temperature of the room. At higher temperatures, 70° to 75° F., the process is relatively rapid. It is very slow below 60° F.

When sufficiently strong, it should be drawn off into full casks and aged for six to twelve months. It may then be filtered or clarified if necessary and placed in bottles or barrels for sale.

Generator Process: Various devices are used to hasten the process of vinegar fermentation. They are called generators and are usually continous in their operation. A generator of a usual size will produce from 25 to 30 gallons of vinegar daily.

The principle used in all of the forms is that of exposing the wine in thin layers or films to the air. As the vinegar bacteria act only in the presence of air, the process is much accelerated. In some forms, the wine is caused to drip slowly over a mass of beech chips or similar material in a tall upright cylinder. In others, the material is placed with the wine in a revolving cylinder so arranged that new portions of the liquid are continually or intermittently exposed to air and the action of the bacteria.

The action of these generators is rapid both because of the full exposure to the air, of the large numbers of bacteria present, and of the high temperature maintained. The high temperature (75° to 80° F.) is produced by the rapid fermentation and by warming the room where necessary.

Vinegars made in this way are not considered of quite such high quality as those made by the slow process, but if the work is skillfully

done and the vinegar is aged for six months or more, the results are excellent. Vinegars made by either of these processes may be either red or white.

Distilled Vinegar: A water-white vinegar can be made by first distilling the wine. The distillate diluted to 10 per cent alcohol is then passed through generators and yields a vinegar of 8 to 9 per cent acetic acid. Such a vinegar is almost neutral in flavor and suitable for pickling and similar uses. It must compete with cheap vinegars and would pay probably only as a by-product for the utilization of inferior raw material.

Cost and Returns: Grape vinegar can be made for approximately the cost of wine or a little more. It should be possible to produce a good vinegar for a wholesale price of 25 cents to 30 cents per gallon and pay $15 to $20 per ton for the grapes.

The market for vinegar is limited, irrespective of price. Perhaps one or two million gallons of good wine vinegar could be marketed at a profit.

5. *Industrial Alcohol*: It has been suggested that industrial alcohol be made from wine grapes by fermentation and distillation with the equipment already installed in wineries.

One ton of grapes of 22° Balling would yield about 20 gallons of 95 per cent alcohol. This, at a high valuation of 50 cents per gallon, would yield $10. About 10 pounds of cream of tartar could be recovered as a by-product. This, at 25 cents per pound, would bring the gross returns to $12.50. After paying the costs of manufacture, this would yield the grower of the grapes about $5 or $6 per ton, which would not pay the cost of cultivating the vineyards.

6. *By-products*: In the manufacture of grape juice, syrup and vinegar, the pomace or solid matters of the grape would remain. The pomace from a ton of grapes weighs from 250 to 350 pounds and contains valuable matters. It contains about 15 per cent of dissolved solids, principally sugar, which could be extracted by water and used for the production of syrup, vinegar or alcohol. A small amount of cream of tartar could also be recovered from the pomace.

The seeds constitute about 4 per cent of the weight of the grapes (about 80 pounds to a ton). They contain about 8 per cent of oil or nearly one gallon to a ton of grapes. The extracted pomace can be dried and the seeds separated by screening and blowing. The oil can be extracted by grinding and pressing, and is excellent for cooking and table use and also for industrial purposes.

The press cake from which the oil has been extracted is useful as a stock feed or can be leached to recover the tannin.

Bulletin 276 of the United States Department of Agriculture, Bureau of Plant Industry, describes methods of utilizing grape seeds. This can be had by applying to the United States Department of Agriculture, Washington, D. C.

C. GRAFTING WITH OTHER VARIETIES.

In some cases it will be possible to change the crop from wine grapes to raisin or table grapes by grafting. This can be done profitably in only a small percentage of the vineyards, but in the aggregate this may represent a considerable area.

Various considerations must be taken into account in deciding on the advisability of making this change.

1. The suitability of the new variety for the local conditions and the probable future for this variety.

2. The cost of the operations, including the loss of crop during the period of change.

3. The probable length of productive life of the grafted vineyards.

1. *Varieties*: Any variety can be grafted successfully on any other variety by the method recommended for this purpose and described in Circular 115 of the College of Agriculture at Berkeley.

Raisin grapes, of course, should be grafted only in the raisin districts, where it is possible to dry raisins profitably. The Black Corinth, from which Greek currants are made, is being grafted on to wine grapes in the coast counties. It is doubtful whether these grafts will be permanent, for reasons discussed later. Moreover, it is still uncertain whether the crop can be dried in the sun in these regions. The grapes ripen early and dry rapidly, so it is possible that the drying may be successful. The yield and the cost of production are still unknown. The indications from the experience of growers and experiments made by the station are that the crops will be smaller than those of other raisin grapes and that the cost of production will be larger. At the prices paid for currants during the last few years, they would probably be profitable in spite of these disadvantages, but it is doubtful whether we could compete with the Greek producers in normal times.

Table grapes in the same way should be considered only in the table grape districts. Only where ordinary table grapes are successful will grafted table grapes give good results.

2. *Cost of the Operations*: A skillful grafter should be able to insert 400 or 500 scions a day in as many vines. He would require two to three men to assist him in digging around the vines, placing the stakes, and covering the grafts. Each vine must be staked and a considerable amount of careful handwork will be needed in suckering and tying up the grafts. The cost of grafting an acre of vines (600) may be estimated as follows:

Cost of Grafting One Acre of Vines.

Grafting, skilled man at $5.00 per day	$7 00
Helpers, 2 men at $3.00 per day	8 00
Stakes, 36-inch, at 4 cents	24 00
Suckering and tying	5 00
Total	$44 00

The vines will bear nothing the year they are grafted. The second year they should bear from one-fourth to one-half of a full crop. To the cost, therefore, must be added the loss of at least one and a half crops.

If the vines are small, 2 inches to 3 inches in diameter, the cost of grafting may be a little less; if they are large, over 4 inches in diameter, it may be considerably more.

3. *Longevity of Grafted Vines*: When an old vine is grafted, the union is never perfect, nor does the wound heal over completely as in the case of walnuts and apples. It is probable that the old stump usually dries and finally dies. If the method described in Circular 115 of the College of Agriculture, Berkeley, is followed, however, this is not of much importance. This method recommends grafting five or six inches below the surface of the soil and the use of a long scion. When this is done the scion makes its own roots. The stock lives long enough to stimulate the scion to a rapid and vigorous growth of top and a rapid and vigorous growth of root, and by the time the stock dies or weakens, it is independently established on its own root system. It is possible that where very large vines are grafted, the presence of the large mass of decaying stock may be a source of danger to the young vine.

The grafting of vines in the coastal and other regions where the phylloxera exists presents peculiar, if not insuperable, difficulties.

All vines under these conditions which are worth grafting at all are on American or phylloxera-resistant roots. In grafting such vines, there are three possible methods, each of which has its disadvantages.

First, we may graft the vines just above the ground in the scion or vinifera part of the vine. This is possible if we cover up the graft with a good mound of loose soil until the union is formed. Such unions, however, as already pointed out, are imperfect and the life of the graft is not likely to be long.

Second, we may graft six inches below the surface, as recommended for vinifera stock. In this case we obtain an excellent growth and the scion variety will form its own roots, as already described. Vines grafted in this way on American vines free themselves more quickly from the stock than those grafted on vinifera vines, such as wine grapes. This would be an advantage but for the presence of phylloxera. The scion roots are susceptible to the attacks of the insect and if the vine depends on them for sustenance, it will be killed. This is exactly what occurs when grafted nursery vines are planted too deeply in new soil. The union between vinifera scion and American stock is imperfect and as soon as the scion roots are well established the food supply flows directly into them and the starved American stock soon dies.

There is a possibility that in grafting old resistant vines in this way the course of events may be somewhat different. If there is an abundant supply of the insects in the soil at the time of grafting, it is possible that

they will congregate on the scion roots, which they prefer. In this case, these roots may be prevented from developing, with the consequence that the food material from the leaves may flow into the American roots and keep them alive and healthy. If this occurs, it is possible that the vines may remain vigorous indefinitely. This is exactly what is reported to have occurred in Champagne where vines grafted below ground on resistant vines in the presence of phylloxera have remained healthy and profitable for over twelve years.

The unions between vinifera varieties and American stocks when the latter are older than one or two years are, however, usually very imperfect and many vines are likely to die, even though the possibility suggested by the experience in Champagne should be realized here.

A third method of grafting would be to graft on to the resistant stock as near the surface of the soil as possible and then to prevent the development of the scion roots by keeping the soil hoed away from the vine and removing the roots as they appear. This is an expensive and troublesome operation and the same difficulty of imperfect unions exists.

D. CHANGING THE CROP.

1. *Removal of the Vines*: In many cases any attempt to save the vineyard by one of the preceding methods is almost certain to be unsuccessful. In such cases, the problem is to remove the vines in the most economical manner and to replace them with the most profitable crop.

The methods of clearing off the vines are similar to those of clearing off brush, though, owing to the uniformity of the vines, more economical and systematic methods can be used.

The vines, if small, can be dug out by hand or pulled out by a team of horses or a tractor. Most stump pullers are unnecessarily powerful and cumbersome. Modified stump pullers have been made which work rapidly and efficiently. Where vines have to be taken out on a large scale, a special tool can be made. Such a tool made by the Killefer Company was used to take out large numbers of vines in the Stanford vineyard in Tehama County. The tool was drawn by a powerful tractor. The cost was $7.59 per acre for labor, distillate and oil, and the gathering and burning of the stumps cost $3.50, or a total of $11.09 per acre. The same tool used by Stern & Son in San Bernardino County was pulled by a 75-horsepower Holt tractor and cleared 16 to 20 acres per day of 10 hours. At Kearney 8,244 vines were removed by means of a tractor and a subsoiler at a cost of $10 per acre, or $0.017 per vine. This included the labor, fuel, and the gathering of the stumps into windrows. In the operation, the land was subsoiled to a depth of 22 inches.

2. *Replanting*: When a piece of land has been occupied by vines for many years, it is doubtful policy to replant with new vines or even with fruit trees.

Owing to our method of handling vineyards with clean cultivation, it is very difficult to keep the soil permanently in good physical condition. The organic matter of the soil finally becomes exhausted and is hard to replace, owing to the difficulty of growing green-manuring crops in a vineyard and the practical impossibility of obtaining sufficient manure or similar organic fertilizers. The only resource at present available is an alternation or rotation of crops.

The best method of renewing the soil of an exhausted vineyard is to replace the vines with alfalfa wherever this crop can be grown profitably. After a period of several years, the land will be in excellent condition again for vines or fruit trees. Where alfalfa can not be successfully grown, annual crops should be grown for several years before replanting vines. If a heavy growth of bur clover, alfilaria or similar plants can be plowed in the year before replanting, the vines will have a much better opportunity to develop well.

E. SUMMARY AND CONCLUSIONS.

The possibilities of the salvage of wine-grape vineyards will vary with their location and condition.

Three typical regions may be considered, viz., those characterized by the growing of (*a*) raisins, (*b*) table grapes, (*c*) dry-wine grapes.

San Joaquin Valley: Young vineyards (under 10 years) in good condition may be transformed into raisin or table-grape vineyards by grafting. The cost may be estimated at $35 to $45 for the operation, or, if we include the loss of one and one-half crops at $15 per ton, a total of about $150 per acre.

The crops of older vines may be sun-dried. Whether this will be permanently profitable is doubtful, but at present prices would pay fairly well. It might tend to disturb the market for raisins.

A limited portion of the crop could probably be used for grape syrup and yield a fair price to the growers. It is a question whether this industry could be developed profitably on a large scale, if at all, in time to save any appreciable part of the wine-grape vineyards.

Removal of the vines at a cost of $10 to $15 per acre and substitution of an annual crop seems the only recourse in many cases.

These conclusions apply to any districts where the sun-drying of grapes is feasible.

Sacramento Valley: The grafting and removal of wine grapes are practicable under the same conditions as in the San Joaquin Valley. Drying wine grapes may also be successful. Here, however, it will be necessary to adopt the methods of dipping and sulfuring used for Sultana raisins and perhaps in most cases the use of evaporators. If the dried grapes are to be used for wine, artificial evaporation is to be preferred.

The Coast Counties: In the dry-wine regions of the coast counties the possibilities of salvage are less than in the interior. Changing the varieties by grafting is almost certainly useless, both because of the difficulty of grafting on resistant vines, and because of the improbability of growing raisin or table grapes profitably except in rare cases.

If the drying of wine grapes for wine-making purposes should be feasible, the coast county grapes dried in evaporators will undoubtedly be superior.

If grape juice of fine quality can be marketed profitably, it is the best grapes of the coast counties that must furnish the raw material.

For the cheaper canned Muscat juice, it is probable that the color and acidity of the coast grapes may be useful in giving variety and freshness and thus utilize a small portion of the crop.

It seems inevitable, however, that most of the wine grapes of this region will have to be abandoned or removed. The case is more serious here than in the interior, as much of the land is unsuited to any other crop, or much less profitable.

A careful survey of a typical area has been made by C. F. Shaw of the College of Agriculture. This area includes 21,365 acres of grapes in the Healdsburg district of Sonoma County and includes all the vineyards from Sebastopol and Santa Rosa north to the Mendocino line. According to this survey, 45 per cent of the vineyards are on soil well suited to other fruits. The loss in these would be confined to the cost of changing the crop and the loss of crop during the process. Of 27 per cent of the vineyards, the soil can be used for other fruit, but with less profit than with grapes. Here the loss would be greater. In the remaining 28 per cent, the soil, after the vines are removed, is only adapted for pasture. Here the loss would be almost total.

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